

## CLAIMS

1. A CAD/CAM system for design and manufacture of a hearing aid housing comprising a face plate and a shell that is matched to the auditory canal of a user, the system being adapted to
  - 5 receive and process data representing the shape of the auditory canal,
  - forming a three-dimensional model of the shell based on the data, and
  - outputting data representing the model for production of the shell and the face plate based on the model.
- 10 2. A CAD/CAM system according to claim 1, further adapted for selection of a junction contour encircling the shell for positioning of a junction between the hearing aid shell and the face plate.
- 15 3. A CAD/CAM system according to claim 2, further adapted for inclusion of the junction contour in a face plate model, and for transfer of the data representing the model to a numerically controlled machine that automatically cuts a separately manufactured face plate along a contour that matches the junction contour.
- 20 4. A CAD/CAM system according to claim 2, further adapted for inclusion of positioning means in the shell model to engage with corresponding positioning means of the face plate so that the circumference of the produced face plate matches the junction contour of the produced shell when the face plate positioning means engage with the shell positioning means.
- 25 5. A CAD/CAM system according to claim 1, further adapted for formation of a three-dimensional model of the face plate that matches the shell at a selected junction contour encircling the shell, and for integration of the face plate model and the shell model into one three-dimensional model of the hearing aid housing so that a hearing aid housing with an integrated face plate may be produced based on the hearing aid housing model.
6. A CAD/CAM system according to claim 1, further adapted for selection of shape, dimensions, and position of at least one microphone opening in the face plate, and for inclusion of the at least one microphone opening in the face plate model.

7. A CAD/CAM system according to claim 1, further adapted for selection of shape, dimensions, and position of a battery opening in the face plate facilitating insertion and removal of a battery, and for inclusion of the battery opening in the face plate model.
8. A CAD/CAM system according to claim 7, wherein the battery opening is adapted for passage of a battery and an electronic module, and further adapted for including engaging means in the face plate model for receiving and removably holding a socket, the electronic module comprising the socket, at least one microphone, a signal processor, and a receiver.
9. A CAD/CAM system according to claim 8, further adapted for including engaging means at the battery opening in the face plate model, comprising grooves, tracks and/or notches for engagement with co-operating socket engaging means formed on the socket.
10. A CAD/CAM system according to claim 1, further adapted for selection of shape, dimension, and position of an acoustic output opening in the hearing aid shell for transmission of sound from the hearing aid towards the tympanic membrane, and for including a model of the opening in the shell model.
11. A CAD/CAM system according to claim 10, further adapted for selection of the position of the acoustic output opening so that the acoustic output opening emits sound in the direction of a longitudinal axis of the auditory canal thus, minimizing the risk of the acoustic output opening emitting sound towards a wall of the auditory canal or even being partially or entirely occluded by an auditory canal wall.
12. A CAD/CAM system according to claim 1, further adapted for including a ventilation channel in the model.
13. A CAD/CAM system according to claim 12, further adapted for selection of a path along which the ventilation channel is intended to extend.
14. A CAD/CAM system according to claim 13, further adapted for determination of the position and the geometry of the ventilation channel opening in the face plate facilitating automatic production of the face plate with the ventilation channel opening.
15. A CAD/CAM system according to claim 14, further adapted for selection of a position of an in-the-ear ventilation channel opening so that the ventilation channel opening points in the direction of a longitudinal axis of the auditory canal when the housing is inserted in the auditory canal.

16. A CAD/CAM system according to claim 10, further adapted for including a pipe stub in the shell model centered around the output opening and extending inwardly in the shell model forming a bushing for insertion of an ear wax guard.
17. A CAD/CAM system according to claim 16, further adapted for including a recess in the shell model covering an area around the output opening and matching an abutment collar of the ear wax guard or, matching an abutment collar of a bushing to be inserted in the opening for reception and holding of the ear wax guard.
18. A CAD/CAM system according to claim 1, further adapted for selection of a tightening contour that extends along the surface of the shell at least partly encircling the shell.
19. A CAD/CAM system according to claim 18, further adapted for increasing the outer dimensions along the tightening contour thereby providing a tight seal against the auditory canal wall when the shell is inserted in the auditory canal.
20. A CAD/CAM system according to claim 18, further adapted for including a groove extending along the contour in the model having a cross-section with a shape and dimensions that match a desired tightening ring to be mounted in the produced shell.
21. A CAD/CAM system according to claim 18, further adapted for including a groove extending along the contour in the model for deposition of a material different from the material of the shell in the groove, the deposited material constituting a tightening ring.
22. A CAD/CAM system according to claim 18, further adapted for selecting positions of the tightening contour at positions corresponding to positions in the auditory canal at which the dynamic variations of the dimensions of the auditory canal exhibit the least variations whereby a secure and tight mounting of the shell in the auditory canal is provided independent of user activity.
23. A CAD/CAM system according to claim 1, further adapted for outputting the data to a remote site for production of the hearing aid housing.
24. A CAD/CAM system according to claim 1, further adapted for forming an ear model of the auditory canal and a part of the outer ear based on the data.
25. A CAD/CAM system according to claim 24, further adapted for distinguishably displaying the ear model and the housing model.

26. A CAD/CAM system according to claim 25, further adapted for displaying the ear model transparently facilitating display of the shell as inserted in the auditory canal.
27. A CAD/CAM system according to claim 1, further adapted for selectively increasing the outer dimensions of the hearing aid shell model so that the corresponding hearing aid shell  
5      exerts a pressure on the auditory canal tissue when the shell is inserted in the auditory canal.
28. A CAD/CAM system according to claim 27, further adapted for increasing the outer dimensions uniformly over the entire surface of the shell.
29. A CAD/CAM system according to claim 27, further adapted for reducing the increase of  
10      the outer dimensions gradually along the longitudinal axis of the shell so that very little or no pressure will be exerted on tissue residing deeply in the auditory canal.
30. A CAD/CAM system according to claim 1, further adapted for selecting three-dimensional models of shapes and geometries of various hearing aid components, such as microphones, signal processors, output transducers, from a database for incorporation into the hearing aid  
15      to be manufactured.
31. A CAD/CAM system according to claim 30, further adapted for positioning and displaying models of the selected components within the hearing aid housing model for selection of respective optimum positions, e.g. for provision of a hearing aid of a minimum size.
32. A CAD/CAM system according to claim 31, further adapted for performing collision  
20      checks.
33. A CAD/CAM system according to claim 32, further adapted for performing collision check during movement of a component in the shell along a desired path.
34. A CAD/CAM system according to claim 1, further adapted for selecting the path of the junction contour while the shell is displayed as inserted in the auditory canal for selection  
25      of optimum cosmetic appearance when the hearing aid is inserted in the auditory canal.
35. A CAD/CAM system according to claim 1, further adapted for smoothing the surface of the shell model to eliminate sharp edges and corners and to obtain a smooth surface.
36. A CAD/CAM system according to claim 35, further adapted for selecting specific areas of the shell, e.g. using a computer mouse with a cursor, for smoothing.

37. A CAD/CAM system according to claim 35, further adapted for removing an artifact from the hearing aid housing model by deleting the surface covered by the artifact from the model and calculating a new surface substituting the deleted surface based on the surface surrounding the artifact.
- 5 38. A CAD/CAM system according to claim 1, further adapted for incorporating a serial number or another identification of the produced hearing aid housing into the housing model, e.g. in a selected position, so that the housing may be produced with an inherent identification.
- 10 39. A CAD/CAM system according to claim 1, further adapted for storing the finished hearing aid housing model ready for use as a basis for production of a corresponding hearing aid housing in a database for later retrieval.
40. A CAD/CAM system according to claim 39, further adapted for utilizing the database for further automation of the design process.
- 15 41. A CAD/CAM system according to claim 40, wherein the models are stored in a reduced form requiring a reduced amount of data.
42. A CAD/CAM system according to claim 1, further adapted for forming a patient database comprising records with a patient identifier, e.g. name and number, holding the resulting hearing aid housing model of the patient in question.
- 20 43. A CAD/CAM system according to claim 42, wherein the records further hold respective models of the original impression of the auditory canal of the respective patients, and identifiers and models of the hearing aid components used in the respective patients' hearing aids.
44. A CAD/CAM system according to claim 1, further adapted to receive the acquired data from a remote site for further processing.
- 25 45. A CAD/CAM system according to claim 1, further adapted to output data representing the model to an apparatus for production of the shell utilizing stereolithography.
46. A CAD/CAM system according to claim 1-44, further adapted to output data representing the model to an apparatus for production of the shell utilizing laser sintering.

47. A CAD/CAM system according to claim 1, further adapted to output data representing the model to an apparatus for production of the shell utilizing drop deposition printing.
48. A CAD/CAM system according to claim 1, further adapted to output data representing the model to an apparatus for production of a plurality of shells in one batch.
- 5 49. A CAD/CAM system according to claim 1, further adapted to output data representing the model to an apparatus for production of the shell starting at the corresponding face plate.
50. A CAD/CAM system according to claim 1, further adapted to output data representing the model to an apparatus for production of the shell with an integrated face plate, a part of the face plate including the battery opening being separately manufactured, the shell being  
10 produced starting where the integrated face plate abuts the separately manufactured part of the face plate.
51. A CAD/CAM system according to claim 50, wherein the circumference of the part of the face plate is tapered so that the outer dimension of the part is slightly larger than the inner dimension of the part whereby a light beam propagating vertically towards the part may  
15 impinge on every point of its circumference.
52. A CAD/CAM system according to claim 1-49, further adapted to output data representing the model to an apparatus for production of the shell with an integrated face plate, a part of the face plate including the battery opening being separately manufactured, the shell being produced starting with the end opposing the face plate and terminated with an outward  
20 opening in the integrated face plate having a circumference matching the circumference of the separately manufactured part of the face plate.
53. A CAD/CAM system according to claim 1, further adapted to include a model of receiver holders in the shell for receiving and holding the receiver.
54. A CAD/CAM system according to claim 53, wherein the receiver holders are automatically  
25 adapted to fit a selected receiver.